THE LARVAE OF THE AUSTRALIAN SHEEP BLOWFLIES.

By Mary E. Fuller, B.Sc., Junior Entomologist, Commonwealth Council for Scientific and Industrial Research, Canberra, F.C.T.

(Twenty-two Text-figures.)

[Read 27th April, 1932.]

Introduction.

In order to identify with certainty maggots taken from sheep, it has been found necessary in the past to breed them through to the adult stage. This method of identifying the sheep fly requires a good deal of careful work and considerable delay before results are obtained, and, moreover, is open to grave error. Inadequate breeding technique may result in the loss of much of the material, or one species may overgrow and destroy others, but the greatest danger lies in the lack in most parts of Australia of proper insectary equipment, which makes it almost impossible to avoid contamination by outside flies. Moreover, the survey of species in relation to strike in sheep is greatly simplified by the recognition of the fly in the maggot stage.

The desirability of identifying the larvae of blowflies was recognized by J. L. Froggatt in 1918. He described and figured the spiracles of *Anastellorhina augur* (*Calliphora augur*), *Pollenia stygia* (*Calliphora stygia*), *Pycnosoma rufifacies* (*Chrysomyia rufifacies*), *Pycnosoma varipes* (*Microcalliphora varipes*), *Lucilia sericata* and *Ophyra nigra* (*Peronia rostrata*). The list of species from sheep has since been added to and unfortunately his account is not sufficiently detailed for the recognition of closely related species.

The purpose of this paper is to provide a quick and satisfactory method of identifying the sheep fly larvae.

The following species have been recorded from live sheep. They are arranged in order of succession, which is just as marked on the sheep as it is in carrion (Mackerras, 1931).

Primary.—*Lucilia cuprina* Wied., *L. sericata* Mg., *Calliphora stygia* Fabr.,* *C. augur* Fabr., *C. fallax* Hardy (one record only).

Secondary.—*Chrysomyia rufifacies* Macq., *C. micropogon* Bigot, *Microcalliphora varipes* Macq., *Sarcophaga* (3 spp.).

Tertiary.—*Peronia rostrata* A.D., *Musca hilli* J. & B., ? *Ophyra nigra* Macq.

All the measurements and descriptions are taken from full-grown third instar larvae. By the time strike is noticeable on a sheep in the field, the maggots are mostly in the third stage. They reach this by the end of the second and on the third day on the living animal, or even sooner with some species in warm

* This species appears to be replaced in Western Australia by *C. australis* Boisd.

weather. The third instar maggot may be recognized by the presence of three slits in the posterior spiracles, regardless of the size of the body.

A detailed description of the larva of *C. stygia* is given, and the others are compared with it. This account should serve to explain the terms used in the other descriptions.

The descriptions and drawings of mouth parts and spiracles are from mounted specimens, but it is possible with the aid of the key and the descriptions to identify any maggot without mounting any of the parts.

The writer wishes to thank Dr. I. M. Mackerras for material and notes and for his interest and assistance in the preparation of the manuscript.

Key to Larvae.

1. Peritreme closed; button or external scar of spiracles situated in peritreme (Calliphorinae) 2
   Peritreme open; button indistinct, in gap of peritreme (Chrysomyiinae and Sarcophaginae) 6
   Peritreme closed; button on spiracular plate internal to peritreme (Muscidae) 9
2. Spiracles very large (more than 0·4 mm. across), separated from one another by less than the spiracular length; peritreme scalloped and wide ..... *C. stygia.*
   Spiracles much smaller (less than 0·3 mm. across) 3
3. Spiracles separated by more than the spiracular length; peritreme not scalloped, narrow ..... *C. fallax.*
   Spiracles separated by not more than the spiracular length 4
4. Peritreme scalloped and fairly wide, with portion round button projecting prominently; slits far apart, angle of bottom slit with horizontal 13° to 15° ..... *C. augur.*
   Peritreme not scalloped, narrow; spiracular plates separated by less than the spiracular length; angle of bottom slit with horizontal 32° to 35° 5
5. Spiracles pear-shaped (longer than broad); peritreme thin and narrow; slits long and thin ..... *L. sericata.*
   Spiracles rounded, smaller; peritreme thicker and wider; slits shorter and wider ..... *L. cuprina.*
6. Spiracular plates hidden in deep fossa; peritreme with wide opening; slits thin, sloping outwards and downwards (inner and middle) and outer slits vertical; angle between spiracles re-entrant (Sarcophaginae) ..... *Sarcophaga* spp.
   Spiracular plates visible; peritreme opening narrower; slits wide and thick; angle between spiracles acute or obtuse (Chrysomyiinae) 7
7. Larvae hairy (tuberculate) 8
   Larvae smooth ..... *Ch. micropogon.*
8. Large larvae (up to 16 mm.), very hairy, greyish in colour; peritreme forked at the opening, which is narrow ..... *Ch. rufifacies.*
   Small maggots (up to 11 mm.), much less hairy, brownish; peritreme opening wide ..... *M. varipes.*
9. Slits very sinuous; peritreme wide ..... *M. hilli.*
   Slits slightly sinuous; spiracular plate heavily chitinized, and perispiracular gland openings conspicuous; peritreme narrower ..... *P. rostrata.*
   Slits straight and arranged like Calliphorid; peritreme narrow but heavily chitinized ..... *O. nigra.*

Calliphora stygia Fabr.

The average length of the full-grown, third-stage larva is 19 mm. It is whitish in colour, robust, thick in the middle, pointed anteriorly and broadly truncated posteriorly. The segmentation is well marked, the anterior borders of all the segments bearing bands of small brown spines.

The head is divided into two lobes, each bearing near the apex a small lightly chitinized papilla representing the antenna. This consists of two segments, a larger basal one and a small, dome-shaped, apical one. Close to this, but below the apex, is a small tubercle surrounded by a yellow chitinous ring

enclosing a group of minute colourless papillae. This represents the maxillary palp. Ventrally the lobes bear well developed oral grooves converging towards the mouth. Just above this the oral hooks project ventrally from between the lobes.

The three thoracic segments increase in width from the head backwards. Each is bordered anteriorly by a band of several rows of spines. The band on the first segment is wider and very spiny, especially ventrally. Near its posterior border this segment bears the anterior spiracles, consisting of a pair of chitinous fan-like structures, one on each side.

The first four abdominal segments have the anterior bands of spines well developed all round, but in the rest they are scanty dorsally. Ventrally on each abdominal segment the anterior edge is swollen and raised and the bands of spines widened at this point, making a spiny pad on the ventral surface of each segment. Near the centre of these pads is a clear smooth patch. The first to the seventh abdominal segments are all similar, but the eighth is very short and has a deep postero-dorsal hollow in which the spiracles lie. On the dorsal rim of this hollow are three pairs of large fleshy papillae, and there are three more pairs on the ventral rim, the innermost lower pair being much smaller than the others. The ninth segment is very small and consists of a dorsal swollen part covered with spines and two large lateral projections below this. The tenth segment consists of two small smooth flaps lying between the processes of the ninth and with the anus between them.

Buccopharyngeal armature (Text-fig. 1).—This consists of three parts on each side. The posterior part is the pharyngeal sclerite (PH). It has a deep incision at the posterior end forming the dorsal (DV) and ventral cornua (VC). In this species the pharyngeal sclerite is comparatively long and narrow, the dorsal cornu being very long. The ventral surface is ribbed, showing that the species is characteristically saprophagous in habit. There is a pair of slender hooked rods (R) projecting from the anterior end of this sclerite above the middle or hypopharyngeal sclerite (HP). The chitin is thinner along the dorsal edges of the dorsal cornua, and in the centres of the ventral cornua and also along the ventral edges of the sclerite. Anteriorly at the narrow part below the slender rods it articulates with the hypopharyngeal sclerite. This is small and heavily chitinized, with a projecting ventral portion. In front of this and articulated with its anterior end are the oral hooks. These are wide and somewhat triangular at the base, strongly chitinized, not very sharply curved and rather blunted at the extreme end. Projecting forwards between them is a thick chitinous bar (B). The dental sclerite (D) is a small, thick, somewhat crescent-shaped part at the base of the oral hooks on the ventral side.

Anterior spiracles.—There is a wide felt chamber at the end of the tracheal trunks, and this terminates in 11 or 12 finger-like processes which spread fan-wise and are well separated. Each has a small opening in the end surrounded by a thick chitinous rim.

Posterior spiracles (Text-fig. 2).—The distance between the spiracular plates averages 0·335 mm. The length of the plate is 0·397 mm. and the breadth is 0·420 mm. The plates are almost round in outline with a slight bulge at the button. The peritreme (P) is wide and strong and it is distinctly scalloped on the inner surface, that is, it has inward projections between the slits, that

between the inner and middle slits being bifid. The button or external scar (B) is a clear opening completely enclosed in the peritreme. The three slits are straight, long and narrow, running the entire length of the plate. They are close together near the button and then are directed outwards and upwards, the lower slit being least and the upper slit most inclined upwards. Each slit is rounded at the ends and is surrounded by a thick scalloped chitinous border, the actual slit itself being narrow and crossed by a network of chitinous bars. The distance between the outer and middle slits is less than that between the inner and middle slits, Froggatt's "intermediate structure" (IS) coming between the last two. There are four openings of perispiracular glands (PSG) in the form of clear spaces in the ground membrane of the plate. These occur, one at the top of the intermediate structure, one on the upper margin of the inner slit and the lower margin of the outer slit about their middles respectively, and the fourth on the outer margin of the middle slit towards its top end. From the openings of the perispiracular glands a series of chitinous hairs radiate out to the peritreme. Many of these bifurcate at the ends. Except round the slits and in the intermediate structure the ground membrane of the plates is very thin and transparent.

The maggots of *Calliphora stygia* have been obtained from sheep from Canberra, Albury, Jerilderie and Inverell. The writer is indebted to Dr. Holdaway and Mr. Mulhearn for material from the last three localities.

Calliphora fallax Hardy.

The average length of the full grown maggot is 18 mm. It is white in colour and not quite so robust as *C. stygia*, although very similar to it. In general structure these two species are almost identical. They can only be separated on the structure of the mouth parts and the posterior spiracles.

Buccopharyngeal armature (Text-fig. 3).—The pharyngeal sclerite is shorter than in *C. stygia*, both cornua, particularly the dorsal one, being much shorter. The hypopharyngeal sclerite is practically the same. The oral hooks are more sharply curved and more pointed, and are wider in the base than those of *C. stygia*. There is a slight constriction in the middle of the hooks in *C. stygia*, but this is absent in *C. fallax*. The oral bar between the hooks and the dental sclerite is essentially the same.

Posterior spiracles (Text-fig. 4).—The distance between the plates is 0·285 mm. The length is 0·275 and the breadth 0·280 mm. Thus the plates are separated by more than the spiracular length, whereas in *C. stygia* they are separated by less. The plates are also noticeably smaller and more delicate. The peritreme is narrower and either entirely without scallops or inward projections, or, if these are present, they are poorly developed and indistinct. The slits are straight and equal distances apart. The middle one does not come as close to the button at its lower end as the other two. The button is enclosed in the peritreme, but the peritreme bulges outwards at this point and does not show an inward curve round the button as well as in *C. stygia*. The prominence of the button gives a point to the plate, which shows a tendency to become pear-shaped.

The maggots of *Calliphora fallax* were obtained from an experimental sheep in Canberra by Dr. M. J. Mackerras, and are believed to be the first of this species recorded from the live animal, although it is likely that they have been bred

before, but the species not recognized as distinct from *C. stygia*. This species has only recently been described (Hardy, 1930) and the maggot has not been recorded previously.

Calliphora augur Fabr.

The average length of the maggot when full grown is 18 mm. It is white in colour, robust and very similar in appearance to the other two Calliphoras described above. The segmentation, the details of spines and papillae, the papillae round the dorsal spiracular hollow, and the characters of the 9th and 10th abdominal segments are practically the same. The anterior border of the first thoracic segment is, however, very spiny and there is a ventral fold just behind the spiny band. This segment also has a slight constriction just before the middle. The head lobes seem to be more pointed than in the other species, and the antennae particularly small.

In the anterior spiracles there are 9 to 11 processes, spread out and well apart as in the other two maggots.

Buccopharyngeal armature (Text-fig. 5).—The pharyngeal sclerite is not quite as long as it is in *C. stygia*, but is longer than in *C. fallax*. It is comparatively broad, being much wider than in *C. fallax*. The general shape of this sclerite is the same as in the other two Calliphoras, the dorsal cornua and the inner edge of the ventral cornua being, however, slightly curved. The ribbed pharynx and the anterior projecting rods are the same as the others. The hypopharyngeal sclerite is the same shape as the others, but is much shorter than in *C. stygia*. The oral hooks are slightly different in shape, being shorter and rather flattened along the dorsal surface, curving sharply downwards into a point at the extremity. The bar between the hooks, the dental sclerite and other features are the same as in the other species.

Posterior spiracles (Text-fig. 6).—The plates are 0·230 mm. apart on the average, but in some examples are much closer. They are closer together than in the other two Calliphoras, being separated by much less than the spiracular length which averages 0·275 mm. The breadth is 0·305 mm., so the plates are noticeably broader than long. The peritreme is wide and strongly chitinized, scalloped with strong inward projections between the slits. The button is particularly prominent, causing a sudden bulge in the outline of the plate, which is a good diagnostic character. The slits are straight and, as the plate is broader than long, they appear short and well separated. Of the three Calliphoras, *C. augur* has the slits farthest apart from each other. The structure of the slits, the perispiracular gland openings and chitinous radiations are similar to the other species described.

The maggots of *C. augur* have been taken from sheep in Canberra, and from Albury, Jerilderie and Inverell.

Lucilia sericata Mg.

The average length of the full-grown maggot is 14 mm. The colour is deep cream with pinkish tinges. The maggot is comparatively slender and cylindrical, all the abdominal segments being about the same circumference. The thoracic segments have the anterior bands of spines well developed and wide. The spines are very small. The first thoracic segment is constricted behind the head and has a ventral fold. The ventral spiny pads on the abdominal segments are similar

to those of the *Calliphora* larvae, but the spines are smaller. The spiracular hollow on the 8th segment has an almost perpendicular face with a dorsal shelf bent sharply almost at right angles to it. The spiracles are situated on the upright posteriorly directed face. There are the usual six pairs of papillae on the rim of this hollow and the 9th and 10th segments are as in *Calliphora* maggots.

The head is like the other maggots described, and the antennae and oral grooves are conspicuous.

Buccopharyngeal armature (Text-fig. 7).—The whole structure is smaller and more delicate than in the Calliphoras. The pharyngeal sclerite is very similar in shape, with curved rods projecting from the anterior end and a ribbed ventral surface as in the others. Only the anterior and middle of the sclerite and the inner edges of the cornua are heavily chitinized, the rest being thin. The hypopharyngeal sclerite is short and the same shape as in the other larvae with the ventral projection narrower. The oral hooks are rather short and thick with a heavy base and are not very long or curved; they are relatively blunt at the end. The dental sclerite is present and somewhat crescent-shaped. There is no bar between the hooks. This is the chief difference from *Calliphora* maggots.

Posterior spiracles (Text-fig. 8).—The plates are on an average 0·199 mm. apart and 0·270 mm. long, being thus separated by much less than the spiracular length. The breadth of the plate is 0·249 mm. The plates, being longer than broad and coming to a gradual point at the button, are pear-shaped. The peritreme is narrow and not very heavily chitinized. It has no inward projections. The button is enclosed in the peritreme. The three slits are long and straight, equal distances apart, and more inclined upwards than in the Calliphoras. The details of the slits, perispiracular gland openings and chitinous radiations are the same as in the others described.

In the anterior spiracles there are ten finger-like processes, slender and well spread out.

Very few larvae of this species have been obtained from the fleece of live sheep. There is only one case recorded here from a mixed infection on a sheep in the field at Canberra, but it has produced experimental strike in the insectary.

Lucilia cuprina Wied.

The average length of the maggot is 12 mm. Its colour and form are the same as in *L. sericata*, but it is slightly more robust. The head is similar, but the antennae are much less obvious. The papillae around the posterior spiracles are slightly shorter and less prominent. The 10th segment is more prominent, showing a papilla on each side of the anus. In every other feature, except for difference in the spiracles and mouth parts, it resembles *L. sericata*.

Buccopharyngeal armature (Text-fig. 9).—The mouth parts are smaller and more slender than in *L. sericata*. The cornua of the pharyngeal sclerite are chitinized along their inner edges only, the rest being yellow and transparent. The ribbed pharynx and anterior rods are the same as in the other species. The hypopharyngeal sclerite is slightly longer. The hooks are the feature by which the mouth parts of the two species may be distinguished. The base is much smaller and narrower. The actual hook is longer, more slender and curved and very sharply pointed. The dental sclerite is the same and there is no oral bar present.

Posterior spiracles (Text-fig. 10).—The distance between the plates is 0·175 mm. The length is 0·220 mm. and the breadth 0·215 mm. The plates are rounded

in outline. The peritreme is wider and darker than in *L. sericata* and, like it, has no inward projections. The button is enclosed in the peritreme, but makes no bulge in the outline of the plate. The slits are short and stumpy, and inclined upwards at about the same angle as in *L. sericata*. Apart from any other feature, both Lucilias may be distinguished from the Calliphoras by noticing that the lower or outer slit is practically horizontal in *Calliphora* and inclined at about 45 degrees in *Lucilia*.

There are seven or eight processes in the anterior spiracles and they are rather wider and shorter than in *L. sericata*.

Of the two species of *Lucilia*, *L. cuprina* is the common one on live sheep, and although the two are very closely related, it is possible to distinguish between the larvae. Maggots have been obtained and flies bred from such widely separated localities as Canberra, Albury, Jerilderie and Inverell in New South Wales, and Springsure and Winton in Queensland.

Chrysomyia micropogon Bigot.

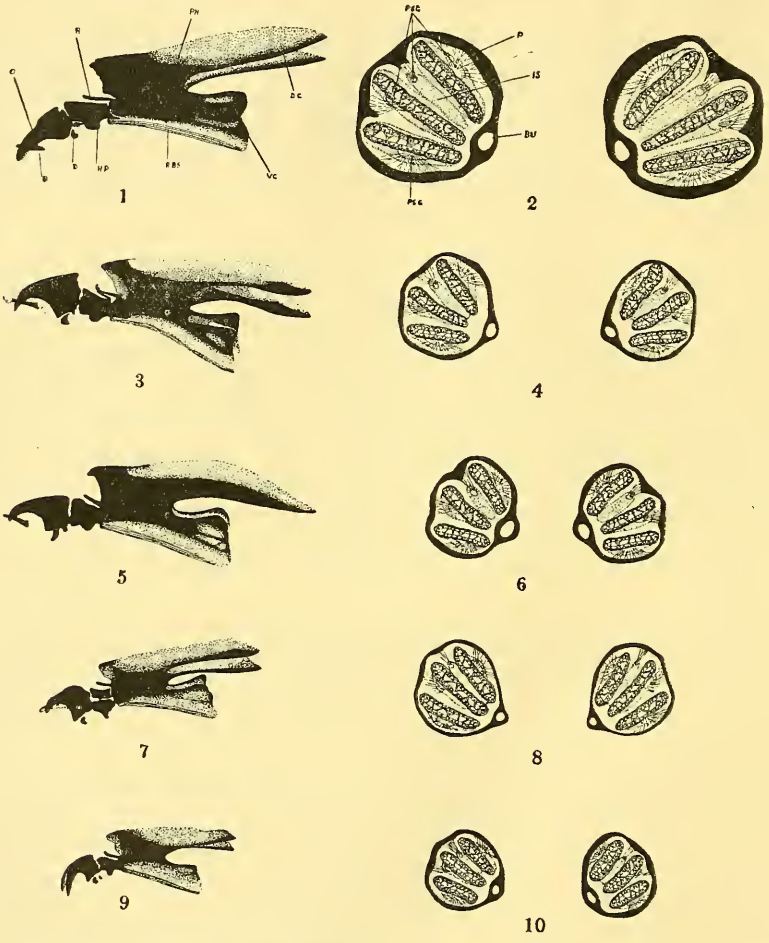
The average length of the maggot is 16 mm. It is robust and whitish in colour. The third thoracic segment and the first six abdominal segments have their anterior margins very swollen, making annulations round the body. Ventrally on each of the abdominal segments, including the seventh and eighth, the ring widens to form the usual ventral pad. Each of the segments has a secondary fold in the middle, but these folds have no spines. The swollen anterior margins of the segments are covered with spines. The spines are scattered and have no regular arrangement on the bands. They are short, colourless, with dark tips. Laterally there is a small swelling between each of the abdominal segments. This is covered with spines like the annulations. The head is very small and the oral grooves are highly developed. The antennae and maxillary palps are of the usual types.

The eighth segment consists of a spiny pad ventrally and a deep postero-dorsal hollow, the spiracles being situated at the anterior end of the hollow. The rim is divided into six pairs of well developed papillae. The ninth segment is spiny on the posterior and ventral surfaces and has two prominent lateral papillae. The tenth segment consists of two smooth lips enclosing the anus. The spiracular hollow is deeper than in *Calliphora*.

Buccopharyngeal armature (Text-fig. 11).—The mouth parts are large. The pharyngeal sclerite is the usual shape. The ventral cornua have a hump on the inner edge and slope back to a point on the outer extremity. This makes them longer than those of any of the previous species, so that here the dorsal and ventral cornua are more equal in length. The ribbed pharynx and the anterior rods are as in others described. The hypopharyngeal sclerite is of the usual shape, but rather narrow for the size of the other parts. The hooks are large and massive, the base being broad, with a backward projection on the lower edge. The hook part is long, curved and sharply pointed. The dental sclerite is large. There is no oral bar between the hooks, but a small sclerite below and away from the hooks.

Posterior spiracles (Text-fig. 12).—The plates are very large, being slightly bigger than those of *C. stygia*. The distance apart is about 0·225 mm. The length is 0·397 and the breadth 0·435 mm. The peritreme is wide and dark and dips inwards slightly between the slits. It is interrupted at the button, where it becomes very thin and transparent, making an apparent gap. The button is in

this gap and is almost invisible. The slits are straight and very wide, with thick chitinous borders. They are close together, occupying practically all the plate. The intermediate structure between the inner and middle slits is narrow. The perispiracular gland openings are large and conspicuous and the radiations from them very numerous and fine, many being forked at the ends.



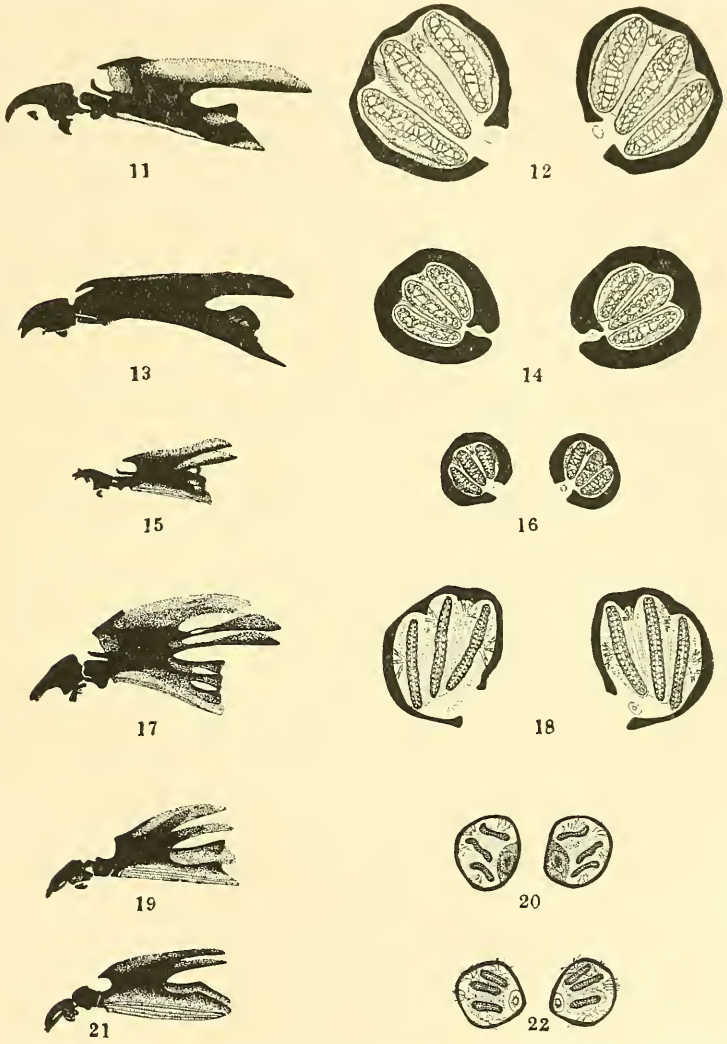
Text-figs. 1-10.—Buccopharyngeal armature (× 22) and posterior spiracles (× 53) respectively of 1-2, *C. stygia*; 3-4, *C. fallax*; 5-6, *C. augur*; 7-8, *L. sericata*; 9-10, *L. cuprina*. B, bar; BU, button; D, dental sclerite; DC, dorsal cornua; HP, hypopharyngeal sclerite; IS, "intermediate structure"; O, oral hooks; P, peritreme; PH, pharyngeal sclerite; PSG, perispiracular gland openings; R, rods; VC, ventral cornua.

Chrysomyia micropogon larvae were collected on sheep at Springsure by Dr. I. M. Mackerras, and have also been obtained from Winton.

Chrysomyia rufifacies Macq.

The full-grown maggot averages 14 mm. in length. It is robust, thick and broad. The skin is a dirty-yellowish colour with grey tinges on the dorsal surface.

It is thickly covered with small, dark, blunt papillae. There are the usual swollen pads on the ventral surface at the anterior edge of each segment, but they are divided into a narrow ridge bearing one row of dark spines and a wider swollen part with several rows, the two being separated by a smooth level area. From the 5th to 8th segments the spines are not well developed on the posterior part



Text-figs. 11-22.—Buccopharyngeal armature (× 22) and posterior spiracles (× 53) respectively of 11-12, *Ch. micropogon*; 13-14, *Ch. rufifacies*; 15-16, *M. varipes*; 17-18, *Sarcophaga* sp.; 19-20, *P. rostrata*; 21-22, *O. nigra*.

of the ventral swelling. Ventrally also and behind the raised part, bringing it near to the posterior edge of the segment, is a ridge bearing a row of six long fleshy protuberances. This is not present on the eighth segment. Running from the sides across the back, just in front of the middle line of each segment, is

a row of long fleshy papillae directed backwards. These increase in size up to the middle of the dorsal surface; each is covered near the base with little dark knobs, and the tip is crowned with a cluster of tiny spines. There are eight papillae in each row, four on the back and two at each side. They are present on every segment of the abdomen up to the seventh and also on the thoracic segments, but are there smaller and shorter.

The head is of the usual form, but very small and pointed, and the thoracic segments are narrow. The anterior border of the first thoracic segment is very densely covered with strong black spines and is slightly constricted just behind this area. The anterior border of the other two thoracic segments is also marked by a band of spines all round. The eighth segment has the usual truncated postero-dorsal surface, the spiracles being conspicuous and situated towards the anterior end. It is surrounded by six pairs of very long fleshy papillae which are clearly annulated and crowned by a ring of tiny black spines. The ninth segment is long and protrudes well behind the eighth and is covered, especially round the posterior edge, with strong dark spines. It bears two small white papillae laterally. The 10th segment is smooth and white, consisting of two flaps with a small papilla on each.

Buccopharyngeal armature (Text-fig. 13).—The mouth parts are distinct from any of those described above. The pharyngeal sclerite is remarkably elongated and narrow and heavily chitinized. It is divided at the posterior end into the two cornua as usual, but, unlike all the others, these are of the same length. The lower edge of the ventral cornu is produced into a long point and the inner edge shows a conspicuous hump. Ventral pharyngeal ribbings are absent, which Keilin considers to be evidence of a predaceous habit. The narrow anterior rods are absent, but the dorsal front edge of the sclerite is narrowed and pointed. The hypopharyngeal sclerite is massive and appears to be fused with the pharyngeal sclerite. It has a narrow part divided off ventrally. The hooks are strong, thick, wide, sharply pointed and curved. The dental sclerite is large and there is no oral bar between the hooks.

Posterior spiracles (Text-fig. 14).—The plates are on an average 0·217 mm. apart. They are 0·337 mm. long and 0·315 mm. broad. The peritreme is very wide and dark and the plates are rounded in outline. The peritreme is scalloped on the inner edge, having projections between the slits. There is a gap at the button and the peritreme is slightly forked at this point, the gap being much narrower than in *Ch. micropogon*. The button is inconspicuous and pale. The slits are straight and very wide, with strong borders, almost filling the plate so that the intermediate structure is compressed and narrow. The perispiracular gland openings and the chitinous radiations are of the usual form.

There are nine or ten processes in the anterior spiracles which are like all the others in structure and shape.

This species has been collected from sheep at Canberra and at Springsure, Queensland.

Microcalliphora varipes Macq.

The average length of the maggot is 10 mm. It is dirty-yellowish in colour with brown tinges on the back. The three thoracic segments are narrowed and elongated. The whole skin is finely rugose. The first abdominal segment is also narrowed and the rest much wider, so that the maggot has a neck-like anterior end. The band of spines at the anterior borders of the thoracic segments is wide, and the spines are brown with very sharp points. The head is of the

usual structure. The first to the seventh abdominal segments bear on the dorsal surface a row of four fleshy protuberances along the middle. The top of each is crowned by a cluster of tiny sharp black spines, with the exception of those on the first segment. Laterally each segment comes to a blunt point, giving the maggot a scalloped appearance down the sides. This part is covered with minute, fine, delicate spines. Ventrally the anterior swelling of the segments is almost imperceptible and can only be distinguished by the double row of dark spines present in this region. The truncated surface of the eighth segment is not hollowed, the spiracles being displayed conspicuously. The usual six pairs of papillae are borne around the edge of this part, but they are short and not as outstanding as the segmental protuberances. The ninth segment is spiny, projects beyond the eighth and bears two very small white papillae at the sides. The tenth segment is white and consists of two ventral papillae with the anus between.

The details of the head including the palps and the oral grooves are similar to the others described. The anterior spiracles are large and wide for the size of the maggot. There are 9 or 10 processes which are strong, wide and well spread out.

Buccopharyngeal armature (Text-fig. 15).—The mouth parts are smaller than any described above. The pharyngeal sclerite is of the usual shape. The incision is not very deep and the ventral cornua are rather wider than usual. The pharynx is ribbed and there are a pair of narrow rods anteriorly. These are longer than usual, running the length of the hypopharyngeal sclerite. The hypopharyngeal sclerite is long and narrow and divided anteriorly. The oral hooks are strong and heavy and readily detached from the hypopharyngeal sclerite. They are strongly curved and sharply pointed and have a chitinous bar between them. The dental sclerite is small and crescent-shaped.

Posterior spiracles (Text-fig. 16).—The plates are close together, being separated by only 0·142 mm. They are 0·172 mm. long and 0·202 mm. broad. The peritreme is very wide and dark, slightly scalloped on the inside, and with a gap at the button. The general appearance of the plate is rather like *Ch. rufifacies* on a smaller scale, but in *Microcalliphora* the plate is broader than long. The slits are short and wide, almost filling the plate as in *Chrysomyia*. The other features are the same. The button is pale and inconspicuous and is situated in the gap of the peritreme.

The larvae of *M. varipes* have not as yet been obtained by us from live sheep. Froggatt in 1915 bred it from sheep at Brewarrina.

Sarcophaga sp.

The maggot is 14 mm. long when full grown. It is very stout and robust, with a tough creamy-yellowish skin. The skin is covered all over with small, blunt, colourless tubercles. There are extra folds and prominences obscuring the ordinary segmentation. Dorsally it is possible to see the normal segmentation, but ventrally it is very difficult. In the middle of each abdominal segment underneath is a row of large protuberances as well as the usual spiny swelling of the anterior border. These spines are colourless. Laterally on the abdominal segments there are also fleshy protuberances. The thoracic segments are smoother and without extra folds. The eighth segment has a very deep spiracular hollow in the form of a narrow-mouthed fossa, so that the spiracles are not visible externally. This distinguishes a *Sarcophaga* from any other maggot. The edges

of this fossa bear the usual six pairs of papillae in the same relative positions as in the other maggots described. The skin of the three thoracic segments is not tuberculate all over, but undulating and marked with crack-like lines. Their anterior borders are spiny. The head is bilobed and of the usual form, with antennae, palps and oral grooves like the others. The whole maggot has a dull, rough appearance as compared with the shining smoothness of the *Calliphora* and *Lucilia* maggots. The anterior spiracles have 15 to 18 processes, which are short and crowded together. The end of the spiracles and felt chamber is wide.

Buccopharyngeal armature (Text-fig. 17).—The pharyngeal sclerite is short and wide, and the incision at the posterior end between the cornua is deep and wide. The outer edges of the cornua are only lightly chitinized. The ventral cornua are much shorter than the dorsal, and the dorsal cornua are more curved than in Calliphorine larvae. The ventral cornua are straighter on the inner edge and rather narrower than any previously described. The pharynx is ribbed and there is a pair of projecting rods at the anterior end of the sclerite. The hypopharyngeal sclerite is wide and strong, with the typical Calliphorid ventral hump. The oral hooks are rather short, thick, blunt at the ends and not very curved. There is no bar between them. The dental sclerite is irregularly shaped and narrower than in the Calliphorines.

Posterior spiracles (Text-fig. 18).—These are the most characteristic feature of the *Sarcophaga* maggot. The plates are D-shaped, sloping slightly towards each other, and there is a wide gap in the peritreme at the inner edge ventrally. The button is very difficult to distinguish and is situated just inside this gap. The peritreme is narrow and scalloped on the inside by the projections between the slits. The slits are long, narrow and delicate, with a similar structure to those of other maggots, but their disposition in the plate is curious and characteristic of the genus. Instead of running from the button outwards, they are almost perpendicular, with the inner two inclined in the opposite direction to those of other maggots; that is, they slope in a dorso-medial direction from the button. The perispiracular gland openings are in the same relative positions as in other genera. The chitinous processes radiating from them are not in the usual form of thin rays, but are wide, branched structures forking at their distal end.

Sarcophaga froggatti has been recorded from sheep by Taylor, and Froggatt records *Sarcophaga aurifrons*. Whilst at Springsure, Dr. Mackerras bred two other species. One of these has been used for the description in this paper. All Sarcophagas are extremely similar in all stages and are very characteristic, so that any could be recognized from the one described. No attempt has been made to separate the species in the larval stage.

Peronia rostrata R.D.

The length of the full-grown larva is 15 mm. It is a deep yellowish-cream in colour, and unlike a Calliphorine maggot in being slender, shining and waxy in appearance. The segmentation is not well-marked, especially dorsally, as the segments are not banded with spines or swollen at their anterior borders. However, each of the second to the eighth abdominal segments has a raised area ventrally at the anterior edge bearing two rows of rather large colourless spines directed backwards. There is a smooth patch between the rows of spines. There are also a few rows of smaller spines on the anterior borders of the thoracic segments.

The eighth segment is smooth and shining, and has no spiracular hollow,

the pair of very chitinous spiracular plates being raised and borne on the posterodorsal face of the eighth segment. The usual twelve papillae are present around this truncated part, but they are very flattened and inconspicuous. The ninth segment is below the eighth and entirely ventral in position, a character which distinguishes Muscid larvae from those of Calliphorines. It consists of a prominent spiny area bearing six large smooth papillae running in a row, three each side of the middle line. The tenth segment is represented by two small yellowish flaps surrounding the anus.

The head is the same as in other maggots, but the antennal palp is more noticeable, as the basal segment is elongated. The oral grooves are present, but are colourless and not very conspicuous. The anterior spiracles have 7 or 8 elongated, slender and delicate processes which are well separated from each other.

Buccopharyngeal armature (Text-fig. 19).—The pharyngeal sclerite is short and wide. The incision in the anterior end is remarkably wide, and the dorsal and ventral cornua are of the same length. The dorsal cornua are arched and curved. The pharynx is more strongly ribbed on the floor than in blowflies. There are no anterior rods projecting above the hypopharyngeal sclerite, which is small and of the same general shape as in a blowfly, but bears a small projection on the dorsal surface. The oral hooks are the most distinctive feature. They are entirely different from any yet described. The two hooks are not of equal size, one being much smaller and shorter than the other. They are narrow, differently shaped from those of Calliphorine larvae and have a much narrower base. They are not very strongly curved and are blunt at the ends. There is a large keel-shaped sclerite close to and just below the hooks. The dental sclerite is comparatively large and irregularly shaped.

Posterior spiracles (Text-fig. 20).—The plates are small, close together and roughly D-shaped. The peritreme is narrow and completely encloses the plate without a break. The slits are small, narrow and slightly sinuous, converging at the top end and spreading apart toward the button. They are well separated and have the usual structure. The ground membrane of the plate is more strongly chitinized than in a Calliphorine, the only clear parts being the perispiracular gland openings, which are in the same relative positions, but have a different appearance from those in blowfly spiracles. The chitinous hairs radiating from them are fine, forked and elongated, some appearing outside the peritreme. The button or external scar is near the inner edge of the plate internal to the peritreme. It is large, conspicuous and dark, being quite different from the clear space seen in blowflies.

W. W. Froggatt recorded *Ophyra nigra* from live sheep at Brewarrina and New England in 1916, and J. L. Froggatt, in his paper on the spiracles of Muscoid larvae in 1918, gave a description of the spiracles of the same species. There is little doubt that both these authors referred to *Peronia rostrata*. J. L. Froggatt's description fitting the spiracles of *Peronia* and not *Ophyra*. The two flies have been long confused, so that it is difficult to say which species attacks living sheep, or whether they both have this habit. The larvae of both are therefore described in this paper.

Ophyra nigra Macq.

The maggot reaches only 13 mm. in length when full grown. It is distinguished from all other species by its slender form and bright yellow colour. It somewhat resembles *P. rostrata*, but is not so waxy and shining. It is perfectly smooth, but

the segmentation is well marked by the anterior border of each segment bearing rows of very minute brown spines. These spines are arranged in broken lines and are not developed on the dorsal surface of the last four abdominal segments. They are most conspicuous on the thoracic segments. The usual ventral swellings on the abdominal segments have a peculiar structure. They bear rows of scale-like spines very regularly arranged in a palisade fashion. They are much longer than the other spines, and are pale with brown tips. The head is very small and of the usual shape and structure. The antenna has a long basal segment as in *P. rostrata*. The anterior spiracles are comparatively large, spreading fanwise, with six long slender processes at the end. The eighth segment is peculiar and unlike any other maggot described. It is abruptly truncated, but there is no dorsal face, the free surface being entirely posterior. The edge of this posterior face is raised and has eight large undulations with broad rounded tops. These are the ends of ridges which run the whole length of the eighth segment, giving it a fluted appearance. The posterior face is slightly hollowed and bears the posterior spiracles, each plate of which is raised on a boss of finely striated colourless chitin. The spiracles are inclined sharply inwards towards each other. The ninth segment is very reduced and appears to come from between the seventh and eighth as a small ventral outgrowth. It is more heavily chitinized than the rest, and hence a deep-orange colour. It consists of two projecting areas covered with spines, and between these is the tenth segment which has two spiny papillae, one each side of the anus.

Buccopharyngeal armature (Text-fig. 21).—The pharyngeal sclerite is a little longer, but not as wide as that of *P. rostrata*. It is of a similar shape with a wide incision, and the dorsal and ventral cornua are the same length. The dorsal cornua are arched, and they are narrower than those of a blowfly, whilst the ventral cornua are wider. The floor of the pharynx is strongly and conspicuously ribbed. There are no anterior rods. The hypopharyngeal sclerite is short and thick. The oral hooks are of unequal length, slender, with narrow bases and shaped like those of *P. rostrata*. The dental sclerite is large and complex and there is a small sclerite ventral to the hooks as in *Peronia*.

Posterior spiracles (Text-fig. 22).—The plates are small and close together. They are a short pyriform shape, with the points facing each other. The peritreme is narrow and completely surrounds the plate. The slits are straight, small and well separated, lying almost horizontal and parallel. They have the usual structure. The ground membrane of the plate, as distinct from that of *Peronia*, is thin and clear. The colourless chitinous hairs which project from the peri-spiracular gland openings are thin and branched. They are very long and project well outside the plate. The button is just inside the peritreme on the inner edge at the point. It is large, but pale and not outstanding.

Musca hilli J. & B.

This species has also been bred from sheep, but no larval material is available for study. The fly was bred at Springsure in Queensland by Dr. Mackerras from two old extensive infections in ewes. A description of the larva with figures has been published by Johnston and Bancroft in the *Memoirs of the Queensland Museum*, 1920. The larva is distinguished by the very sinuous spiracular slits.

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